



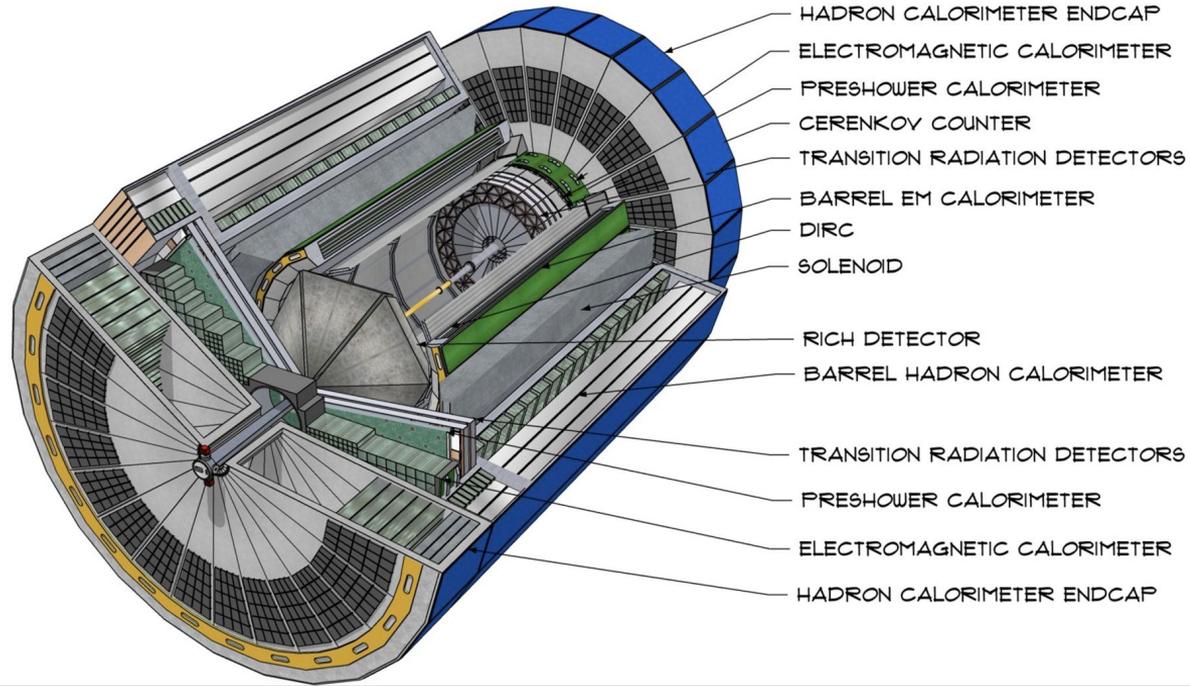
1st Workshop on Artificial Intelligence for the EIC

Organizers:

Amber Boehnlein (JLab), Cristiano Fanelli (MIT/IAIFI), Jan Bernauer (SBU), Tanja Horn (CUA),
Center for Frontiers in Nuclear Science



Artificial Intelligence for the Electron Ion Collider

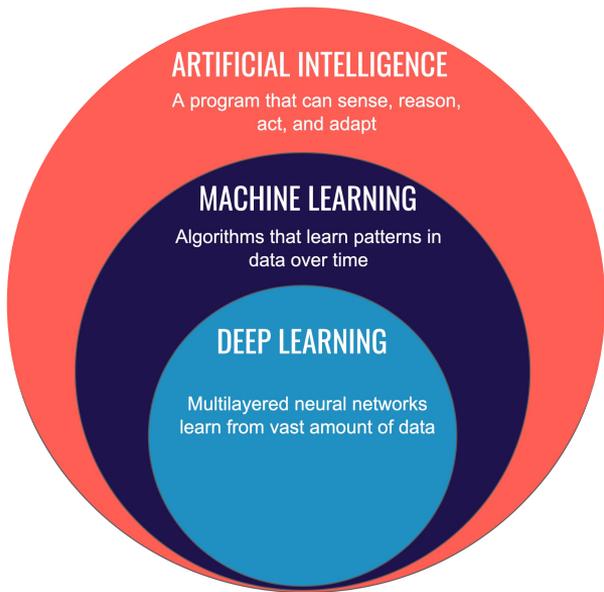


AI4EIC-*exp*

- The focus of this workshop in particular is on Experimental Applications, therefore the suffix “exp” in AI4EIC-exp
- The choice of the naming will allow in the future to organize other workshops which can be either broad in scope, *i.e.*, AI4EIC, or relative to a specific domain of applications (specified by suffix). See [Introduction](#).



AI4EIC



Conveners: Friederike Bock (ORNL), Malachi Schram (JLab)

Accelerator and Detector Design

Conveners: Corey Adams (ANL), Makoto Asai (SLAC)

Simulations

Conveners: Liliana Teodorescu (Brunel U.), Thomas Ullrich (BNL), Yulia Furletova (JLab)

Reconstruction and Analysis

Conveners: Benjamin Nachman, Thomas Britton (JLab)

Accelerator and Detector Control

Conveners: Jin Huang (BNL), Philip Harris (MIT)

Detector Readout

Conveners: Gabriel Perdue (Fermilab), Olivier Pfister (U. Va.), Wouter Deconinck (U.Manitoba)

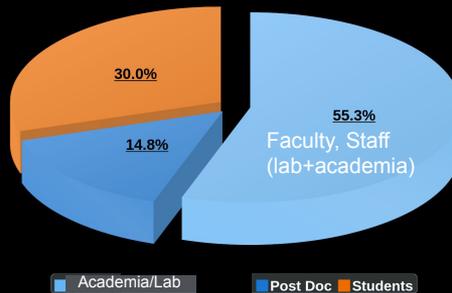
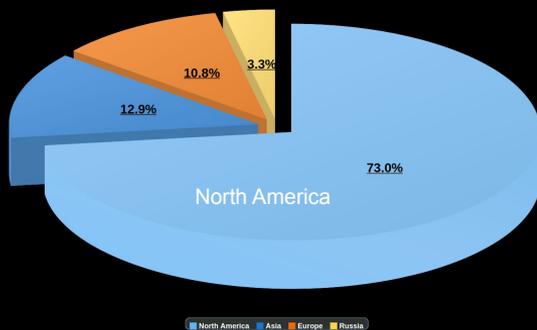
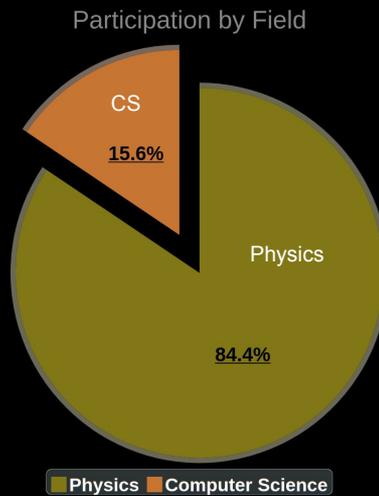
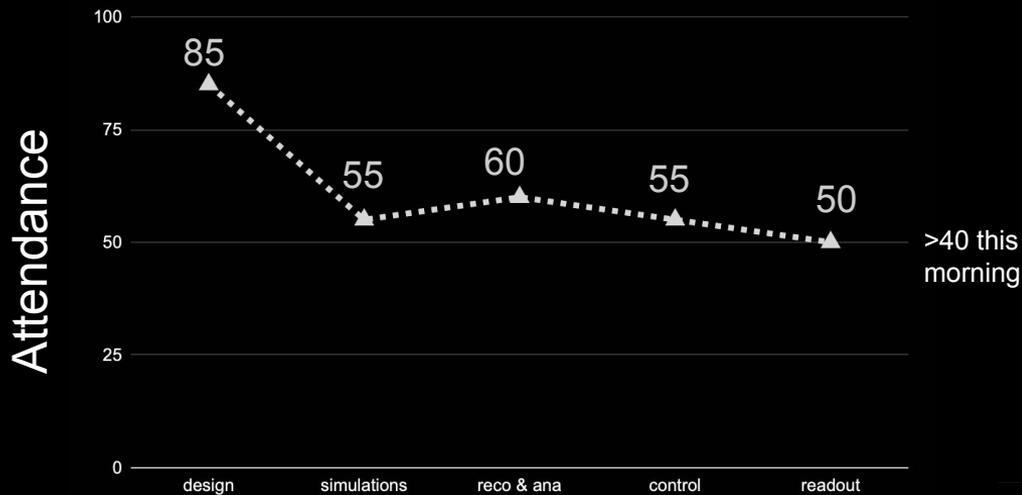
Computing Frontiers

<https://indico.bnl.gov/event/10699/>



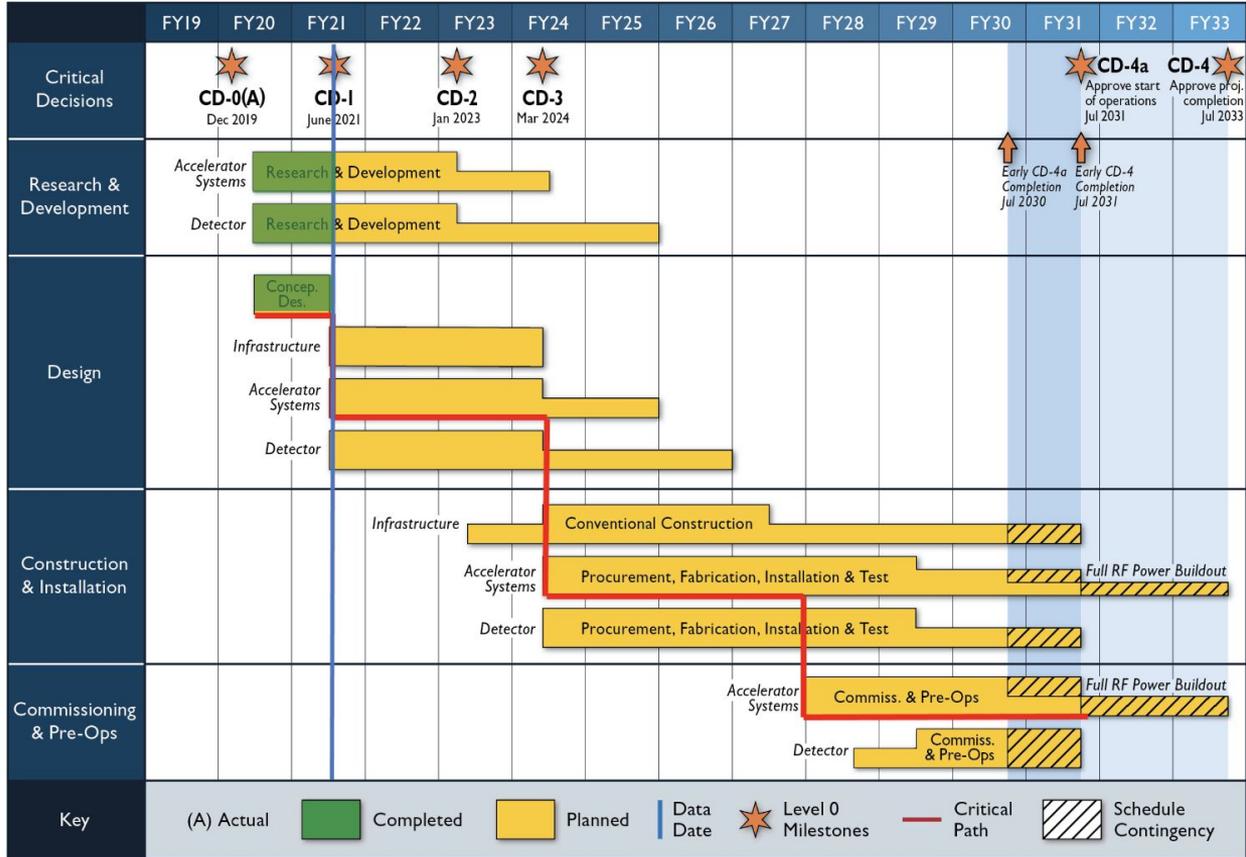
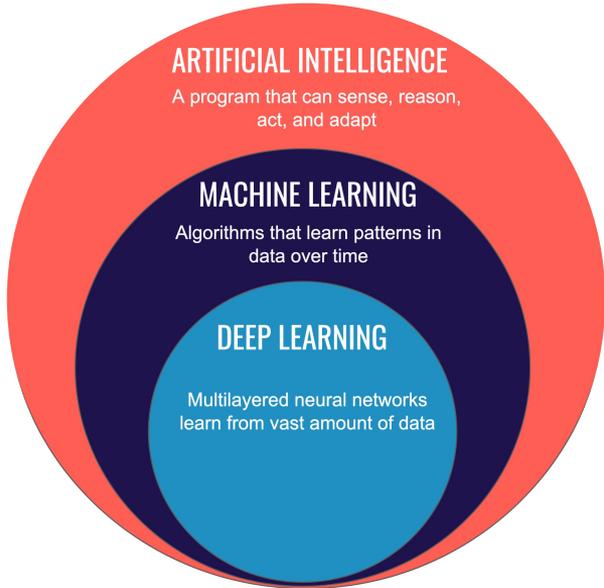
AI4EIC Attendance and Survey

241 registered participants



Credits: K. Suresh

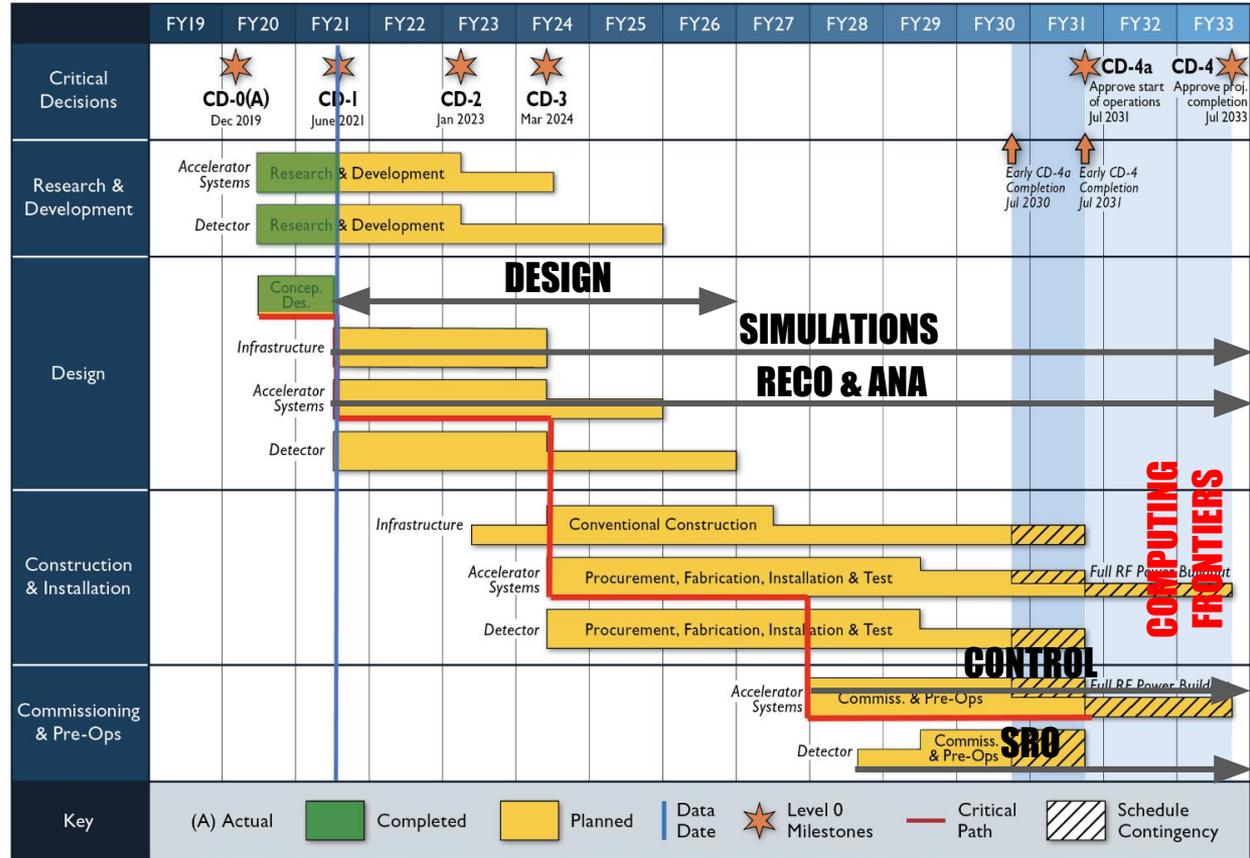
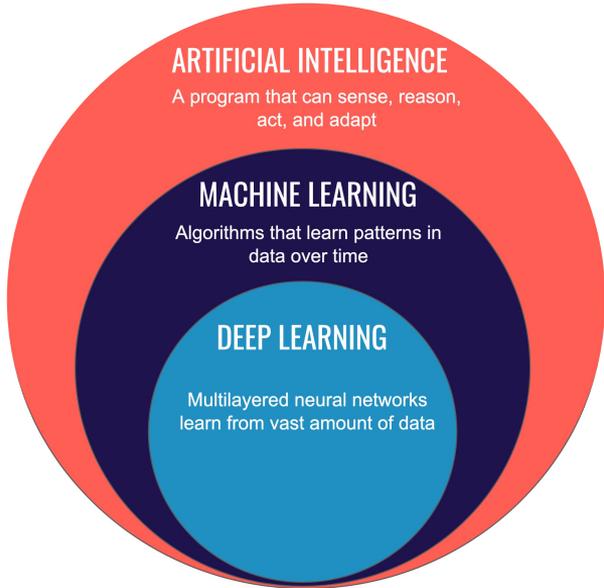
...EIC



See Workshop Introduction with talk on [EIC Overview and Schedule](#) by Rolf Ent



AI...



COMPUTING FRONTIERS

CONTROL

SRO

See Workshop Introduction with talk on [EIC Overview and Schedule](#) by Rolf Ent



Platforms and Documentation

- [AI4EIC Slack](#) been used for organization and during workshop
 - Structured in channels for each session of the workshop
 - Common channel for global announcements
 - Conveners, Organizers channels
- AI4EIC Website <http://eic.ai>
 - Workshop
 - Outreach
 - WGs
- **Live** Q&A Document (link to [google doc](#)): reached >30 pages!
 - Every participant could edit.
 - It has been used by co-conveners to take notes.
 - Thanks to Karthik Suresh for editing support.

Will be used as the basis for
the report writing



For any question:
support@eic.ai



AI4EIC Take away messages

“AI techniques that can optimize the design of complex, large-scale experiments have the potential to revolutionize the way experimental nuclear physics is currently done”.

**AI FOR
SCIENCE**

**RICK STEVENS
VALERIE TAYLOR**

*Argonne National Laboratory
July 22–23, 2019*

EIC is being designed now... will be built over ~ 10 years.

Unique opportunity to start addressing NOW how to take advantage of AI:

- No existing experiment has been designed with the support of AI. **EIC can be one of the first large scale experiments (if not the first one) to use AI in the next few years for that!**
 - AI for design is something relevant for EIC right now and for the next few years during **design and R&D phases**
 - Accelerator and Detector: EIC is an integrated detector (extends for 40 meters considering central + far-forward + far-backward regions) - discussed challenges / opportunities
- Need for faster simulations (both for design and for reconstruction algorithm)
- Reco & Analysis --- **EIC has unique challenges in PID** (see, e.g., discussion on Cherenkov)
- EIC can be one of the first “**automated**” experiments (see Control Session) control workflows
- **Streaming readout at EIC will further the convergence of online and offline analysis:** AI will play a major role in providing fast alignment/calibration/reconstruction for near real-time analyses.
- What opportunities from “**computing frontiers**” in > 2030?

*Computing needs for specialized workflows (automated)?
Heterogeneous Computing?*

3. Advances in the Next Decade

Industrial investment by large-scale cloud companies as well as AI hardware start-ups will continue to drive performance and energy efficiency at scale and at the edge for commercial applications such as image/face recognition, natural language, logistics, voice assistants, and autonomous vehicles. These commercial drivers will infuse AI capabilities broadly, in the scale of data, complexity of function, and robustness that can be achieved. Within the next 10 years, we expect to see the following:

- Introduction of novel AI algorithms, as they are changing quickly and it is difficult to predict popular algorithms for the next decade. Five years ago, LSTMs were new, ResNets were not in use, and transformer networks had not yet been invented.
- Steady increase in the size of largest AI models trainable as well as improvements in training algorithms that reduce the order of

growth in training cost per weight. If the largest model training costs continue their current growth rate of 10x/year, economic and environmental consequences will ultimately be the practical limits.

- Steady reduction and plateau in inference latency and cost to commercially important thresholds (i.e., ~5 milliseconds for human and automobile response times).
- Integration of AI acceleration hardware into all mobile/IoT, and server devices.

These advances will be enhanced by the numerous electronics technology initiatives underway such as the IEEE Rebooting Computing, DARPA Electronics Resurgence Initiative, and SRC's activities like JUMP.

AI for EIC: Broader Scope

- “*EIC has the possibility to incorporate AI from the start*” [see [Michelle Kuchera's talk](#)]
- EIC has the unique opportunity to engage with other communities
 - Challenges, problems - CS, DS now!
 - Collaboration with industry [[comp. frontiers panel discussion](#)]
- We may need to think of new data policy to make data - not necessarily real data - accessible to a broader community --- this involves also hackathons, educational events)
- Young scientists of today will have leading role in EIC in 10 years
 - We need outreach
 - <http://eic.ai>



AI4EIC Outreach

- In 10 years from now when EIC will be operating, AI will be the economic driver in our society.
- Outreach aimed at disseminating AI in the EIC community:
 - Hackathons
 - Schools/Tutorials/Jamboree (in progress)
- We are forming a team of people from different labs and institutions combining expertise in Artificial Intelligence, Electron Ion Collider science and Organization of the above events.



Amber Boehlein
(in progress)
JLAB



Benjamin Nachman
Generative models, likelihood-free/simulation-based inference, anomaly detection, collaboration/IO
BNL



Cristiano Fanelli
AI generative, unsupervised, detector design, particle ID, near real-time collaboration QoS
MIT, IAP



Holoch Schram
(in progress)
JLAB



Markus Diefenthaler
(in progress)
JLAB



Tanja Horn
Calorimetry, detector design, material design, meson structure
CUA



David Lawrence
(in progress)
JLAB



Jan Bernauer
(in progress)
SSU



Jin Huang
(in progress)
BNL



Thomas Britton
(in progress)
JLAB



Will Phelps
AI, Unsupervised Learning, Detector Design, Amplitude Analysis, Fast Histogram, Data Science
CNU



Yuhui (Roy) Ren
DL, MPC, Graph and Network algorithms, Data Analysis and Visualization, Quantitative Modeling
BNL

<http://eic.ai>

How to join:
support@eic.ai



Hackathons

- We envisage two types of Hackathons:
 - **Educational:**
 - See example from [talk given by William Phelps \[1\]](#) @ AI4EIC on the recent Jefferson Lab hackathon
 - https://indico.jlab.org/event/357/contributions/5737/attachments/4863/6064/AI_workshop_hackathon_awards.pdf
 - <https://www.jlab.org/AI/hackathon2021>
 - **Topic specific / data challenge:**
 - Can be built around specific data challenges/existing problem for EIC and help identifying strategies, architectures and algorithms that will benefit the EIC physics program.
 - Various levels of difficulties and duration. Kaggle-like challenge (longer time for submission, working in groups, awards).
 - See examples of TrackML and LHC Olympics in the talks given by [Louis-Guillaume Gagdon \[2\]](#) and [Benjamin Nachman \[3\]](#) during AI4EIC.
- Goal: organize the first hackathon event in 2022 (after detector proposal and review)



Ongoing Discussion

- In 2022 we could have 1-2 hackathon(s)
- Starting 2023 we aim at 2-3 events per year
- Good months (after gathering suggestions) seem to be:
 - April
 - July
 - December
- Idea of “alternating” the organization of these events.
 - A local organizing committee chosen for each event.
- Computing Resources
 - (Informal) availability of Jefferson Lab. Anticipated from BNL and other institutions depending on where the event will take place and if needed.
- How to choose the topic of a “kaggle”-like challenge?
 - Website is the static place where all info are gathered and can be easily found.
 - Idea of a list of topics + inputs from the EIC community (via support@eic.ai or submit form at <http://eic.ai>)
 - The most voted could be proposed as data challenge.
- First meeting for Hackathon --- date to be decided

Kickoff meeting will be announced



Schools/Tutorials/Jamboree (work in progress)

- In 10 years from now when EIC will be operating, AI will be the economic driver in our society.
- Outreach aimed at disseminating AI in the EIC community:
 - **Hackathons**
 - **Schools/Tutorials/Jamboree (in progress)**

E.g., Lectures AI4EIC

See [AI4NP Winter School](#) format,
but with specific applications for EIC

E.g., Data Analyses Presentations

- Lessons Learnt

E.g., learning to use AI tools for data analysis

- Day 1 Tutorial and exercise
- Day 2 Session on doing analysis



Conclusions

- Opportunity to continue this discussion:
 - Planning more AI4EIC workshops in the next years
 - Working Groups are forming
 - Contact people
 - [Slack channel](#)

<https://eic.ai/how-to-join>



- More info on how to submit proceedings will be sent to the invited speakers.
- Thanks a lot for attending so far! We will have a discussion now and then summary reports from all sessions.